CLAIMS

1. An apparatus for acoustically analyzing a fluid comprising:

a chamber for holding the fluid;

a transmitter positioned within the chamber for transmitting an acoustic signal through the fluid;

a reflector moveably positioned within the fluid for reflecting the acoustic signal; and

a receiver positioned within the chamber for detecting a reflection of the acoustic signal.

2. The apparatus of Claim 1, wherein the chamber comprises a sealed first end, a piston slidably disposed within a second end of the chamber and a conduit for introducing the fluid into the chamber.

3. The apparatus of Claim 2, further comprising a servomotor for driving the piston and varying at least one of a pressure and a temperature of the fluid within the chamber.

4. The apparatus of Claim 1, wherein the chamber is thermally insulated to substantially maintain at least one of a pressure and temperature of the fluid within the chamber.

5. The apparatus of Claim 1, wherein the transmitter and the receiver are embodied in a single piezoelectric transducer.

6. The apparatus of Claim 5, further comprising a static piston mounted within the chamber near the first end for supporting the transducer within the fluid.

7. The apparatus of Claim 6, further comprising a square-wave pulsar/receiver connected to the transducer for driving the transducer and processing the reflection of the acoustic signal.

8. The apparatus of Claim 7, further comprising an oscilloscope connected to the square-wave pulsar/receiver for imaging the reflection of the acoustic signal.

9. The apparatus of Claim 8, wherein the reflector is a disc positioned opposite the transducer relative to the piston.

10. The apparatus of Claim 8, wherein the reflector is a ring positioned opposite the transducer relative to the piston.

11. The apparatus of Claim 1, further comprising a first electromagnetic coil and a second electromagnetic coil, the first electromagnetic coil and the second electromagnetic coil being independently driven for manipulating the reflector.

12. The apparatus of Claim 11, wherein the reflector comprises at least one of a first reflective surface and a second reflective surface for analyzing a property of the fluid comprising at least one of velocity, volume, density, compressibility and viscosity.

13. The apparatus of Claim 12, wherein the reflector comprises a material having a substantially low coefficient of thermal expansion and a high bulk modulus for mitigating any variation in a distance between the first reflective surface and the second reflective surface as the material is subjected to a predetermined temperature and pressure within the chamber.

14. An apparatus for acoustically analyzing a fluid comprising:

a chamber for holding the fluid;

a transducer coupled with the chamber for transmitting an acoustic signal through the fluid and detecting a reflection of the acoustic signal; and

a reflector movably positioned within the fluid for reflecting the acoustic signal.

15. The apparatus of Claim 14, wherein the chamber comprises a sealed first end, a piston slidably disposed within a second end of the chamber and a conduit for introducing the fluid into the chamber.

16. The apparatus of Claim 14, further comprising a static piston mounted within the chamber near the first end for supporting the transducer within the fluid.

17. The apparatus of Claim 14, further comprising a first electromagnetic coil and a second electromagnetic coil, the first electromagnetic coil and second electromagnetic coil being independently driven for manipulating the reflector.

18. The apparatus of Claim 17, wherein the reflector comprises at least one of a first reflective surface and a second reflective surface for analyzing a property of the fluid comprising at least one of velocity, volume, density, compressibility, and viscosity.

19. The apparatus of Claim 18, wherein the reflector comprises a material having a substantially low coefficient of thermal expansion and a high bulk modulus for mitigating any variation in a distance between the first reflective surface and the second reflective surface as the material is subjected to a predetermined temperature and pressure within the chamber.

20. A method for acoustically analyzing a fluid in a chamber using a transmitter, a substantially stationary reflector movably positioned within the fluid inside the chamber, and a receiver, the method comprising the steps of:

transmitting an acoustic signal from the transmitter through the fluid; and

detecting reflections of the acoustic signal from the reflector at the receiver.

21. The method of Claim 20, wherein the transmitter and the receiver are embodied in a single piezoelectric transducer.

22. The method of Claim 21, wherein the transducer is supported within the fluid at one end of the chamber.

23. The method of Claim 22, wherein the reflector is a disc positioned opposite the transducer relative to another end of the chamber.

24. The method of Claim 22, wherein the reflector is a ring positioned opposite the transducer relative to another end of the chamber.

25. The method of Claim 20, further comprising the step of determining a property of the fluid comprising at least one of velocity, volume, density, compressibility, and viscosity.

26. The method of Claim 25, wherein the velocity of the acoustic signal through the fluid at a predetermined temperature and pressure ($Vel._{T,P}$) is determined by:

$$Vel._{T,P} = D_{T,P} \div .5 \times (T_2 - T_1).$$

27. The method of Claim 26, wherein the volume of the fluid at a predetermined temperature and pressure ($Vol._{T,P}$) is determined by:

$$Vol._{T,P} = (.5 \times T_3 \times Vel._{T,P}) \times (\pi \times R^2).$$

28. The method of Claim 27, wherein the density of the fluid at a predetermined temperature and pressure ($Den._{T,P}$) is determined by:

$$Den._{T,P} = M \div Vol._{T,P}.$$

29. The method of Claim 28, wherein the predetermined temperature is about 400° F and the predetermined pressure is about 25,000 psi.

30. The method of Claim 26, further comprising the step of calibrating the reflector based upon a known coefficient of thermal expansion for a material comprising the reflector.

31. A method for acoustically analyzing a fluid in a chamber using a transducer and a substantially stationary reflector positioned within the fluid inside the chamber, the method comprising the steps of:

transmitting an acoustic signal from the transducer through the fluid; and

detecting reflections of the acoustic signal from the reflector at the transducer.

32. The method of Claim 31, further comprising the step of determining a property of the fluid comprising at least one of velocity, volume, density, compressibility, and viscosity

33. A method for acoustically analyzing a fluid in a chamber using a transducer and a reflector moveably positioned within the fluid inside the chamber, the method comprising the steps of:

transmitting acoustic signals from the transducer through the fluid; and

detecting reflections of the acoustic signals from the reflector at the transducer as the reflector moves.